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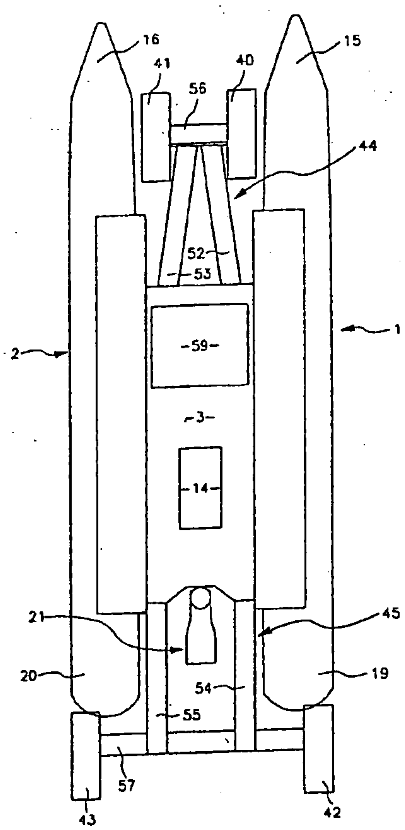
(54) Title: AMPHIBIOUS CATAMARAN



(57) Abstract: Am amphibious catamaran is characterised by the inclusion of two spaced apart hulls (1,2); a framework (3) supporting the hulls; a motor (14) supported by the framework; a drive unit (21) for water propulsion actuated by the motor (14) in use; at least (3) land wheels such as (40-44); two sub-frames (44, 45), each supporting one or more land wheels (40-44); height adjustment means (46; 47) enabling in use one sub-frame, and preferably both sub-frames (44, 45), to be moved with respect to the framework (3) from a position where the land wheels (40-44) stably support the catamaran for travel on land, with the hulls (1, 2) clear of the land, and a position where those of the land wheels (40-44) associated with the movable sub-frame are raised upwardly above the bottoms of the hulls (1, 2); drive means (not shown but including motor (14)) for land propulsion coacting with one or more of said land wheels (40-44); steering means (not shown) for steering the craft on water and on land; and an input station (59) for any person who is to operate the craft on water or on land, or for receiving remote signals to control the operation in use, or both purposes.

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Title

Amphibious catamaran

Background art

Amphibious craft necessarily compromise between adequate water and adequate land performance. Shortcomings frequently exist on entry to, or exit from water onto land.

It was an object of the present invention to yield an amphibious catamaran with improved performance or at least to provide the public with a useful choice.

Disclosure of the invention

The present invention broadly consists in an amphibious catamaran comprising:

two spaced apart hulls;

a framework supporting the hulls;

a motor supported by the framework;

a drive unit for water propulsion actuated by the motor in use;

at least 3 land wheels;

two sub-frames, each supporting one or more land wheels;

height adjustment means enabling, in use, one of the sub-frames to be moved with respect to the framework from a position where the land wheels stably support the catamaran for travel on land, with the

hulls clear of the land, and a position where its associated land wheels are raised upwardly above the bottoms of the hulls;

drive means for land propulsion coacting with one or more of said land wheels;

steering means for steering the craft on water and on land;

and an input station for any person who is to operate the craft on water or on land, or for receiving remote signals to control the operation in use, or both purposes.

An important feature is that the hulls, whether they be rigid or not, are securely fixed to a framework. The forces exerted by water on hulls can be appreciable and this invention eliminates the need for relative movement between the hulls. For example, some other constructions attempting to provide an amphibious craft pivot the hulls about their framework (so that the land wheels can be rotationally fixed to the framework).

With this invention, however, advantage is taken of the fact that land stresses via the land wheels to the framework via the sub-frames are more easily taken care of and thus the land wheels are made to be vertically movable with respect to the framework. Also the framework is able to be kept as compact as possible which means stresses are more easily accommodated.

There is preferably a single motor (preferably a turbo-diesel) providing the motive power for operating all the equipment including driving an hydraulic pump, or pumps, which form part of drive means for land propulsion and which include an hydraulic motor driving each driven land wheel. Similarly the pump or pumps form part of the drive unit for water propulsion which includes an hydraulic motor driving a propeller.

Preferably one or more hydraulic pumps also form part of the land and water steering means which also includes rams or hydraulic motors and they also form part of the height control means via rams controlling the movement of the sub-frames. The hydraulic motors should be reliable in service as water ingress is impeded by internal oil pressure and they are mostly out of the water. There might also be a favourable automatic distribution of power to the motors exerting the greatest effort if they are hydraulically in series.

The hulls are preferably wholly or partly non-rigid and preferably wholly or partly inflatable as that has a number of advantages. Non-rigid hulls partly absorb forces from the water thus reducing the structural strength needed for the framework and are less prone to being damaged or causing damage or injury. The turbo-charger of the diesel motor is preferably used to enable rapid inflation and deflation of the hulls.

At least the front land wheels would preferably be steered. It is actually preferred to oppositely steer both front and rear land wheels to gain an improved turning circle. Also crab-steering is preferably provided.

Many of the functions of the hydraulics and other systems may be computer controlled.

The front and rear sub-frames carry the land wheels at their extremities and are arranged to give leading and trailing arm suspension respectively. The extremities can preferably be swung through appreciable arcs, it being preferable to take them totally out of the water to maximise on-water performance. At their maximum lowering to elevate the hulls a maximum height, the hulls might preferably be totally out of the water while the land wheels might still be wholly or partially submerged. This yields improved traction for beaching the craft and a reduced turning circle as the wheelbase is reduced. An intermediate position would suit safer on-road travel.

By way of explanation "land" when used in this specification includes seabed or any submerged land or any other reasonably solid surface such as a carrier ship loading ramp.

Also the expression "land wheel" is intended to include both conventional wheels and other means of imparting horizontal movement of the craft with respect to land by utilizing frictional contact with the land.

Description of the drawings

The above gives a broad description of the present invention one preferred form of which will now be described with reference to the accompanying drawings in which all figures are highly schematic and do not show accurate constructional details:

Fig. 1 shows a side view of the craft with the hulls at maximum elevation above land

Fig. 2 shows a side view of the craft in normal on-water travelling mode

Fig. 3 shows a side view of the craft in normal on-land travel-at-speed mode

In both Figs 2 and 3 and the remaining figures some of the finer detail of Fig. 1 is omitted for clarity.

Fig. 4 shows an outward view to the left from a plane just central of the motor and steering arrangements of the right front land wheel

Fig. 5 shows the drive unit and depth control means in side view

Fig. 6 shows a cross-section through a hull exploded from a cross-section of a mating portion of the framework

Fig. 7 shows tail adjustment means and

Fig. 8 shows a plan view from above.

Modes for carrying out the invention

The hulls and framework

In a preferred form of the invention as best shown in Figs 1 and 8 an amphibious catamaran has two long, non-rigid, substantially cylindrical, partly inflatable hulls 1,2 perhaps 6 to 7 metres long. These may be spaced apart in parallel a distance so that, at least when deflated, the total width of the craft is at or within the maximum width allowed for road travel without an oversize permit being required. The hulls are kept in their positions by means of a framework 3 of sufficient strength to resist the high forces exerted on the hulls under certain conditions found on the water. The framework might be a fabricated stainless steel, or aluminium, or moulded fibre-reinforced resin composite, open-topped box structure comprising (but not illustrated) a floor and sides and ends and cross members, some of which might be hollow to provide emergency buoyancy or fluid storage spaces. As it is normally above water level the floor can be self-draining.

The hulls are preferably of a diameter of about 650mm although that would vary from one craft to another, depending on the layout and weight etc. However, with that dimension, which would be typical, the outer 25mm could be a closed-cell soft or flexible foam wrapping 4 (Fig. 6) around each inflatable tube 5. The wrapping would be encased in the usual protective fabric 6 which

would substantially or wholly provide the outer surface of the hull. There could be multiple fabric layers. The idea of the foam is to provide additional protection against deflation of the interior tubes (there being say three in all in series) if the hull should become snagged by a fish hook or impaled on some projection, such as a sharp rock. Shapes such as longitudinal strakes of closed-cell foam (not shown) could also be attached to or incorporated under the fabric. The foam helps the inflatable hulls to maintain their shapes as otherwise there is a tendency for them to deform. A craft with these hulls might draw about 300mm of water.

The longer the hulls the better the craft handles waves or rough seas by being able to bridge a longer pitch between waves.

The lower-most part of each hull has adhered to a fabric layer 6 a semi-rigid external boot 7 comprising a band of suitable plastics material which can impart a suitable shape to the bottom of the hull while also protecting the underlying fabric against abrasion if the hull touches land during beaching etc. That reinforcement serves to partially rigidise the lower-most portion of the hull, while yet allowing much of the impact of waves against the hull to be borne by the flexible portion of the hull above it. It functions as a strong-back. Furthermore, it can serve as a mounting for a keel 9, which might be necessary to improve directional performance and to stop chine-walk.

The boot 7 generally has a cupped shape and it might be just, say, 150mm wide or it might encase the lower third of the hull, for instance. It can be extended to the forward part of the hull and a more appropriate shape in that area would be a "V" shape, possibly with a packer between the boot and the round hull. The boot is made of a semi-rigid material which retains its shape against permanent deformation, perhaps nylon or polyethylene, and must be able to be adhered or welded to the protective fabric 6.

A modification is to have an inner "extension"10 of the boot to form a semi-rigid strong-back internal of the fabric 6 but separated from an inflatable tube 5 by an innermost layer of foam 11 while being embedded in outer foam layers and overlaid by the fabric. This extension 10 further reduces the tendency for deformation of the hulls and provides an improved mounting frame for a keel. While the extension would act in conjunction with the boot 7 its shape might be completely different. For example it might be provided as a narrow beam with its depth arranged to be vertical in use as shown in Fig. 6 and the depth might alter along the hull length.

The boot, or preferably any keel mounted on it, can be grounded by lowering to act as a brake for the craft upon transition from water to land, if the approach is made too fast.

Each hull 1,2 is fastened to the framework 3 by means of a bolt-rope track coupling 12,12'; 13,13' on either side of the hull top centre-line. Thus, when the catamaran is supported on its land wheels the hull can be slid out of the track for maintenance, which frequently might require inversion of the hull. This is a feature which is very advantageous where the catamaran is perhaps being used as a rescue craft and needs to be in a perpetual state of readiness as far as possible. A spare hull could be fitted quite quickly, or repairs could be made quite quickly.

The inflation of the hull is preferably from the turbo-charger of a turbo-diesel motor 14. This provides a large quantity of low pressure air and also provides a means of quickly evacuating the air from the hulls. There would be suitable attachments (not shown) to the turbo-charger inlet and outlet and a suitable manifold (not shown) to the inflatable tubes.

The three serially-mounted tubes which are inflatable within each hull may be removed through side access flaps (not shown) in the outer covering fabric 6 and slits in the underlying foam,for repair purposes when needed.

The objective of the hull design is to provide a design which acts well as a displacement hull, is capable of planing efficiently, which is easy to service or repair, and which is relatively resistant to damage while providing a means of absorbing as much of the shock forces caused by water impact as possible.

The boots 7 help with ride softness by retaining the hydrodynamic round shape of the hulls on impact with a wave, thus maintaining the speed of the craft.

Directly above the hulls, supported on the sides of the framework, there may be detachable rigid sealed containers (not shown) adapted to carry tools, equipment and supplies but also capable of functioning as additional flotation in a case where the craft is under a heavy load or when travelling through rough seas.

For extreme safety the inflatable tubes 5 might themselves contain emergency inflatable tubes (not shown), held up high out of harm's way when deflated, which can be filled with air from the turbo-charger, or emergency air reservoir, if ever needed.

The bow or nose 15,16 of each hull can include a tapered closed-cell solid foam core, overlaid by said sheath of closed-cell flexible foam, which in turn is overlaid by the protective fabric. The nose is preferably able to be tilted up to a beaching position via a double-acting ram 17 as shown in Fig. 1.

The stern or tail section 19,20 of each hull is able to be pushed down or pulled up, or both, with respect to the remainder of the hulls 1,2 by tail adjustment means preferably operating via a double-acting ram 18 (Fig 3 and Fig 7).

Each tail 19,20 is also preferably able to be selectively deflated to enable the tail to be pulled up and contracted to facilitate raising or lowering of a rear land wheel such as 42 past the tail or stern as is shown in Fig. 7.

On-water propulsion

The motor 14 is supported by the framework 3 as is a drive unit 21 for water propulsion. This may be a propeller or a jet drive. The preferred option is an hydraulically driven propeller 22 (Fig. 5) mounted on a depth control means 23 which includes a parallelogram linkage enabling the propeller to be lowered deep enough to function properly below the foul water created in the tunnel between the hulls, while enabling it to be raised high enough to avoid damage when the craft is on, or close to, land, maintaining trim all the while. A single or double-acting ram 27 controls propeller height. Conventional stern-legs are not strong enough nor do they have sufficient reach, nor maintain trim when raised. They could also foul the legs or arms 54,55 of the rear sub-frame 45 (yet to be described) if raised while at or close to a full-lock position as the distance between the rear legs is only about 900mm.

The top 24 and/or bottom 25 arms of the parallelogram linkage are adjustable in length to alter the trim of the propeller. The top and/or bottom arms preferably incorporate double-acting pneumatic or hydraulic rams such as ram 26 to effect length adjustment.

Rotation of the parallelogram linkage, or the propeller mounted on it, about a substantially vertical axis such as 29,29', in use, for steering the craft on water, is achieved by another hydraulic motor or a ram or rams (not shown). A conventional outboard motor can move only about 30°to either side of centre but the system for this craft preferably allows much more turning.

The propeller is hydraulically driven via a, usually unsubmerged, reversible hydraulic motor 30 driving a substantially vertical partially submerged shaft (not shown) which drives the propeller via a submerged pair of bevel gears (not shown) in use, all submerged parts being suitably encased in casing 31 and perhaps water-cooled as well.

To achieve the requisite propeller rotational speed the drive to it from its hydraulic driving motor 30 is via a bevel gear pair giving the appropriate step-down from the comparatively high-rotating hydraulic motor. The diesel motor 14 might rotate at 4200 rpm and the hydraulic pump or pumps (not shown) driven by it likewise. The propeller motor 30 might rotate at 3600 rpm in which case the step down might be 1:1.25 for a 15 inch (375mm) diameter propeller.

A propeller shroud 32 (shown schematically) is able to be lowered close to the top of the propeller, or raised away by shroud control means (not shown), to suit water conditions, to increase propeller thrust. It needs to be able to be totally removed from the water when underway to reduce drag.

Subframes

Three land wheels, appropriately positioned, would be capable of supporting the craft on land but there are preferably four for better stability. These land wheels 40,41; 42,43 (Fig 8) are supported for rotation about their substantially horizontal axes on, and at, the extremities of sub-frames 44,45 which are able to be moved, preferably independently, via height adjustment means 46, 47 (shown in Fig. 1 only), with respect to the framework 3, from a position, where the land wheels 40-43 stably support the catamaran for travel on land with the hulls clear of the land, and a position where at least the land wheels associated with the front sub-frame, are raised upwardly beyond the bottoms of the hulls and, usefully, to other positions as well. Preferably all land wheels are so raised. While the land wheels may be located inboard of the hulls, extra stability may be gained if at least one pair of them, perhaps the rear pair 42,43, are more or less in line with the hulls 1,2 but to the rear of them. Balancing factors may mean that the rear sections of the hulls may need to be deflated to get them out of the way when such land wheels are to be moved past the tails 19,20 as has been described with reference to Fig. 7.

The sub-frames 44,45 must be lowerable quite quickly, perhaps under computer control, so that beaching is achieved speedily and accurately and without needing to disengage the propeller, if that is the means of water propulsion, to minimise the chance of a following wave swamping the craft and

also perhaps to maintain approach speed thus facilitating traverse over difficult land with limited tractionability.

There are many possible ways of providing the necessary sub-frame movement but bearing in mind the desirability of having the sub-frames completely clear of the water when the craft is floating and the land wheels likewise, coupled with the need for there to be sufficient elevation of the relatively long hulls necessary to give good performance on water, the best option is to have two sub-frames 44,45 each pivoted to the framework 3. There would be one sub-frame 44 at the front and one sub-frame 45 at the rear of the framework. Hydraulic or air-operated rams 50,51 (only shown in Fig. 1) could be used to cause the sub-frames to be moved from an elevated position in which they were substantially in a horizontal plane to a lowered position in which they each pivoted about a substantially horizontal pivot axis 48,49 (Fig. 1), carrying the land wheels downwardly with them. The angle of pivoting arc could in theory be as much as about 90° to give maximum elevation, but in practice a lesser angle will enable a more stable arrangement; for example the amount of movement about a pivot 48,49 could be about 55°.

It is important, to assist beaching in difficult conditions, that the full weight of the craft be transferable to the land wheels while the craft is still in shallow water. For example the bottoms of the land wheels may be positioned to be 700mm below the bottoms of the hulls. If the hulls are thus completely or

mostly out of water then the land wheels get traction and the chance of a wave overturning the craft is much reduced. The length of each sub-frame 44,45 may be about 1.6m and the land wheel, provided as a conventional wheel, might have a diameter of about 1m.

The legs or arms 52,53; 54,55 (Fig. 8) of the sub-frames might conveniently be provided in part by hollow tubes and suitable tubes might be aluminium mast sections or preferably, for corrosion resistance, stainless steel. These could be designed to provide air reservoir tanks and also hydraulic fluid reservoir and cooling tanks. The ends of the tubes might in any case be sealed to increase overall flotation.

The front and rear sub-frames 44,45 are suitably hinged or pivoted on the framework 3 for independent pivotal movement about substantially horizontal, substantially parallel, axes 48,49 which are substantially perpendicular to the straight-ahead line of travel of the craft in use, and the height adjustment means 46,47 may possibly include air rams (sometimes called bellows or pneumatic actuators or springs) adjacent the hinge axis and powered by an on-board compressor (not shown) driven by the motor 14. While pneumatic bellows provide a useful amount of flotation compared with other options, they have limited travel and are single-acting and for those and for other reasons double-acting hydraulic rams such as 50,51 are preferred. Hydraulic raising and lowering is faster than pneumatics and it is important that the drag created

by the lowering of the sub-frames and associated land wheels be minimised in order not to unduly slow the motion of the craft. Hydraulics allow fast raising and lowering and also allow a greater arc through which the sub-frames may be swung. The improvement over pneumatics might be of the order of 25°.

The sub-frame legs or arms 52-55 might terminate in an axle or crossmember such as 56,57 (Fig 8) which supports at each end an hydraulic motor (not shown) driving an attached land wheel. Kingpin assemblies (not shown) allow for ram-actuated steering (not shown) of all the land wheels. When land speeds are low all may be steered, but when land speeds are to be higher then the preferable rear steering ram or rams (not shown) might be locked, with the land wheels in a straight-ahead position, to give increased stability of the craft, so at higher speeds on land steering is via the front land wheels alone.

There might preferably be locking means (not shown) to mechanically, but releasably, lock the sub-frames in selected positions to reduce stresses on their operative hydraulic systems.

The preferable suspension system uses hydraulic raising and lowering of the sub-frames 44,45 via double-acting hydraulic rams 50,51 with at least one sealed-gas spring (not shown) for example of the kind used on CITROEN [Trademark] cars. The hydraulic circuit (not shown) supplying the hydraulic

rams preferably includes multiple, sealed-gas springs (not shown) at least some of which are selectable to enable choice of suspension firmness.

Access to and from the craft from both land and water is not very practicable over the sides. The sub-frames 44,45 might act as prime means of access to, and egress from, the craft.

The rear sub-frame 45 may be provided with a stepped cover (not shown) so that when the sub-frame is in the lowered position, whether on land or in the water, it can be used for access to the input station 59 or any deck of the craft. In many cases the rear sub-frame, with suitably strong hydraulics, might be useful as a loading device to be lowered under some object to be loaded onto or off the craft to help lift it out of, or lower it into, the water. Otherwise with on-board hydraulics an on-board crane (not shown) could easily be provided for some applications where it would be useful.

Where the sub-frame is suitably constructed it might be transformable to, or useful as, extra temporary decking while not required for landing purposes.

The two spaced apart rear land wheels 42,43 supported on the rear sub-frame 45 have a track which preferably substantially equals the maximum width of the craft across the hulls 1,2. This gives maximum stability while yet facilitating road travel.

There are two spaced apart front land wheels 40,41 supported on the front sub-frame 44 (although there could be a single land wheel) and the track of the front land wheels is less than the minimum spacing between the hulls..

At the front, the sub-frame extremity terminates in the pair of land wheels on a short axle 56 such that the land wheels 40,41 lie in the space between the hulls 1,2 with room for turning when steered, with a central axle pivot axis (not shown) running longitudinally to create a vehicle suspension of three points similar to that used on many agricultural tractors. A central nose cone 60 (shown only in Fig 4) might minimise any bow-wave created by a lowered axle and land wheels and there might be a splash shield (not shown) on the framework or front sub-frame to deflect any spray created by a lowered axle and land wheels from any occupants of the craft.

The hydraulic motors (not shown) for the land wheels might provide means of braking the craft as well as driving it.

When such a craft is being beached the land wheels would preferably be automatically lowered as the craft neared shore, utilizing a sensing device (not shown) adapted to cause lowering when the water floor-level was say 400mm below the hulls but there needs to be a nice balance between the land wheels making ground contact too early and having no traction, and making contact

too late when the hulls might get grounded and damaged. The front sub-frame 44 might be lowered before the rear sub-frame 45 if necessary to facilitate landing.

At the rear there might be an aerofoil (not shown) on the sub-frame, perhaps forming a rear axle 57, the aerofoil being adapted to provide framework 3, and thus hull, lift when the rear sub-frame 45 is lowered into water while there is forward motion of the craft.

Also rear rams (such as 18 in Fig 7) can be adapted to deflect the sterns or tails 19,20 of the hulls downwards which will provide framework lift by virtue of the craft's motion forward. Such a mechanism might conversely provide tail lift to reduce the planing surface and increase on-water speed. Variation side to side could enable a trim-tab like function to counter forces in reaction to propeller torque, uneven loading, wind forces or fast-turning forces.

An option is to have quite large diameter land wheels of conventional wheel type – perhaps up to 1m diameter. In order to avoid lengthening the framework or the rear sub-frame 45, the section of each hull at the tails 19,20 is selectively deflated when beaching or un-beaching the craft, and maybe for road travel at speed and curled by means of a multistage hydraulic ram (such as 18) in a radius tight enough for such a large land wheel to pass around it

(as shown in Fig 7 to some extent). This could apply to both the bow and stern sections of the hulls depending on track width.

An advantage of deflating the tail of each hull during beaching is that this raises the front of the craft and assists beaching.

The height adjustment means 46,47 thus preferably enables each sub-frame 44,45 to be independently (if desired), positioned in at least 3 positions namely:

A fully raised position (as shown in Fig. 1)

A fully lowered position (as shown in Fig. 2)

An intermediate position where the hulls clear land by substantially the minimum amount needed for safe on-road travel (as shown in Fig. 3).

While only two sub-frames 44,45 have been described, more might be provided. For example individual legs or arms 52-55 might form individual sub-frames with each land wheel having its own sub-frame.

As an alternative to car-like steering on land the craft might be skid-steered. In that case the front land wheel or land wheels might be mounted on a substantially vertical pivot for castor action while the rear land wheels would be able to be selectively braked and/or oppositely driven, independently. The rear

land wheels could, as earlier defined, take the form of track assemblies (as might the front) to reduce land pressure. It is even envisaged that the land wheels could take the form of computer controlled feet for human-type walking on the land surface.

Input station

An input station 59 is provided on the craft for any person who is to operate the craft on water or on land or both, and that person might be required to exercise judgement as far as lowering or raising of the land wheels was concerned during launching or retrieval of the craft if that function was not automated. It is, of course, possible that there may be no person on the craft at any time, in which case the input station would be occupied by a receiver (not shown) to receive remote control signals or there could be a combination of such. The input station may include a simple stand-up steering position or a fully enclosed cabin.

At the input station there would be all the necessary controls (not shown) for operating the craft and preferably a computer (not shown) to automate some functions.

Motor

The major ultimate power to effect movement on the craft comes from hydraulic motors or rams. These are preferably driven from a pair of series

mounted hydraulic pumps (not shown) directly coupled to the output shaft of the turbo-diesel motor 14 which would be about 150 to 200HP (110-150kW).

The diesel motor would also preferably operate a generator (not shown) to provide an electrical energy supply and also an air compressor (not shown) providing air at high pressure such as might be needed for operating power tools such as jacks or spreaders to free trapped people who might be held in the wreckage of a downed aircraft etc.

Summary

The advantages of the above-mentioned construction are that the hulls 1,2 are securely fixed to the framework 3 and no compromise needs to be made in that respect. This leads to a construction which has the required strength to resist forces which can be encountered when the craft is on the water, which of course is extremely important for the safety of any occupant or occupants.

It is envisaged that some versions of the craft would not travel at any great speed on land. Perhaps speeds of up to about 40kph might be practicable. The objective would be to have enough land-going capability to enable the craft to be moved to a suitable storage area on land – perhaps the owner's house, if nearby. On-water speeds of about 20 knots or more are desirable. Military objectives might be different.

When used as a rescue vehicle, a deck, if provided on the framework 3, could enable a number of rescue pods (not shown) to be carried and quickly deployed to persons who might be in the water so that a number of people could be offered suitable support as quickly as possible.

Claims

1. An amphibious catamaran characterised in including:

   two spaced apart hulls;

   a framework supporting the hulls;

   a motor supported by the framework;

   a drive unit for water propulsion actuated by the motor in use;

   at least 3 land wheels;

   two sub-frames, each supporting one or more land wheels;

   height adjustment means enabling in use one of the sub-frames to be moved with respect to the framework from a position where the land wheels stably support the catamaran for travel on land, with the hulls clear of the land, and a position where its associated land wheels are raised upwardly above the bottoms of the hulls;

   drive means for land propulsion coacting with one or more of said land wheels;

   steering means for steering the craft on water and on land;

   and an input station for any person who is to operate the craft on water or on land, or for receiving remote signals to control the operation in use, or both purposes.

2. An amphibious catamaran as claimed in claim 1 wherein a front or leading sub-frame is pivoted at its rear to the framework and a rear or

trailing sub-frame is pivoted at its front to the framework, both sub-frames being so pivoted for pivotal movement about substantially horizontal, substantially parallel axes in use which are substantially perpendicular to the straight-ahead line of travel of the craft.

3. An amphibious catamaran as claimed in claim 2 wherein the height adjustment means enables each sub-frame to be positioned in at least 3 positions namely:

a fully raised position

a fully lowered position

an intermediate position where the hulls clear land by substantially the minimum amount needed for safe on-road travel.

4. An amphibious catamaran as claimed in claim 3 wherein the height adjustment means enables the front and rear sub-frames and associated land wheels to be totally raised above the bottoms of the hulls in use.

5. An amphibious catamaran as claimed in any one of claims 1 to 4 wherein the height adjustment means include pneumatic and/or hydraulic rams.

6. An amphibious catamaran as claimed in claim 5 wherein the height adjustment means include double-acting hydraulic rams.

7. An amphibious catamaran as claimed in claim 6 wherein a hydraulic circuit supplying the hydraulic rams includes at least one sealed-gas spring to provide resilience in the suspension of the framework on the land wheels.

8. An amphibious catamaran as claimed in claim 6 wherein a hydraulic circuit supplying the hydraulic rams includes multiple, sealed-gas springs at least some of which are selectable to enable choice of resilience in the suspension of the framework on the land wheels.

9. An amphibious catamaran as claimed in any one of the preceding claims wherein the drive unit is a propeller and the propeller is supported by depth control means, said depth control means enabling the height or depth of the propeller with respect to the hulls to be quickly adjusted to exploit the available depth of water, if any.

10. An amphibious catamaran as claimed in claim 9 wherein the depth control means is a parallelogram linkage adapted to maintain the trim of the propeller at any selected depth.

11. An amphibious catamaran as claimed in claim 10 wherein the top and/or bottom arms of the parallelogram linkage are adjustable in length to alter the trim of the propeller.

12. An amphibious catamaran as claimed in claim 11 wherein the top and/or bottom arms comprise or incorporate double-acting pneumatic or hydraulic rams to effect length adjustment.

13. An amphibious catamaran as claimed in any one of claims 9 to 12 wherein the propeller is hydraulically driven, in use, via a usually unsubmerged hydraulic motor driving a substantially vertical partially submerged shaft which drives the propeller via a submerged pair of bevel gears, in use.

14. An amphibious catamaran as claimed in any of claims 9 to 13 wherein a propeller shroud is able to be lowered close to the top of the propeller by shroud control means, or raised away, to suit water conditions, to increase propeller thrust.

15. An amphibious catamaran as claimed in any one of the preceding claims wherein the hulls are non-rigid.

16. An amphibious catamaran as claimed in claim 15 wherein the hulls are at least partly inflatable.

17. An amphibious catamaran as claimed in claim 16 wherein each hull includes one or more inflatable tubes circumferentially sheathed in closed-cell flexible foam which in turn is enveloped in a protective fabric substantially or wholly providing the outer surface of the hull.

18. An amphibious catamaran as claimed in claim 17 wherein an external surface of fabric, which is at a lowermost portion of each hull, is reinforced externally with a semi-rigid boot.

19. An amphibious catamaran as claimed in claim 18 wherein the boot is provided with a keel.

20. An amphibious catamaran as claimed in claim 18 or claim 19 wherein the boot overlies an internal semi-rigid strong-back embedded in said flexible foam.

21. An amphibious catamaran as claimed in any one of claims 17 to 20 wherein the bow or nose of each hull includes a tapered closed-cell solid foam core, overlaid by said sheath of closed-cell flexible foam, which in turn is overlaid by said fabric.

22. An amphibious catamaran as claimed in claim 21 wherein said nose is able to be tilted up to a beaching position via a double-acting ram.

23. An amphibious catamaran as claimed in any one of claims 15 to 22 wherein the stern or tail of each hull is able to be pushed down or pulled up, or both, with respect to the remainder of the hull by tail adjustment means.

24. An amphibious catamaran as claimed in claim 23 wherein the hulls are at least partly inflatable and wherein the tail is able to be selectively deflated to facilitate the tail being pulled up to facilitate raising or lowering of a land wheel past the tail.

25. An amphibious catamaran as claimed in any one of the preceding claims wherein the hulls are removably attached to the framework by bolt-rope tracks.

26. An amphibious catamaran as claimed in claim 2 or any one of the preceding claims when dependent on claim 2 wherein there are two spaced apart rear land wheels supported on the rear sub-frame and the track of the rear land wheels substantially equals the maximum width of the craft across the hulls.

27. An amphibious catamaran as claimed in claim 26 wherein there are two spaced apart front land wheels supported on the front sub-frame and the track of the front land wheels is less than the minimum spacing between the hulls.

28. An amphibious catamaran as claimed in claim 27 wherein the front land wheels are attached to a centrally pivoted beam axle so that the craft has 3-point suspension.

29. An amphibious catamaran as claimed in any one of the preceding claims wherein all drivable land wheels are drivable in a forward or backward direction.

30. An amphibious catamaran as claimed in any one of the preceding claims wherein all land wheels are steerable.

31. An amphibious catamaran as claimed in claim 30 wherein pairs of land wheels are steerable in opposite directions.

32. An amphibious catamaran as claimed in any one of the preceding claims wherein the hulls are at least partly inflatable and the motor is a

turbo-diesel and the construction is arranged so that the turbo is useable to inflate the hulls.

33. An amphibious catamaran as claimed in claim 32 wherein the construction is arranged so that the turbo is useable to deflate the hulls.

	10751jad.doc Drawing references Catamaran J A Hough
1	Hull
2	Hull
3	Framework
4	Foam-wrap
5	Inflatable tube
6	Fabric
7	Boot
8	
9	Keel
10	Extension
11	Innermostfoam layer
12	Bolt-rope track
12'	Bolt-rope channel
13	Bolt-rope track
13'	Bolt-rope channel
14	Turbo-diesel motor
15	Nose
16	Nose
17	Nose ram
18	Tail ram
19	Tail
20	Tail
21	Drive unit
22	Propeller
23	Depth control means
24	Top arm
25	Bottom arm
26	Ram
27	Height control ram
28	
29	Axis
29'	Axis
30	Propeller motor
31	Casing
32	Shroud
33	Shroud control means
34	
35	
36	
37	
38	
39	
40	Front land wheel
41	Front land wheel
42	Rear land wheel
43	Rear land wheel
44	Front sub-frame
45	Rear sub-frame
46	Front height adjustment means
47	Rear height adjustment means
48	
49	

50	Front ram
51	Rear ram
52	Front leg
53	Front leg
54	Rear leg
55	Rear leg
56	Front axle
57	Rear cross-member
58	
59	Input station
60	Cone

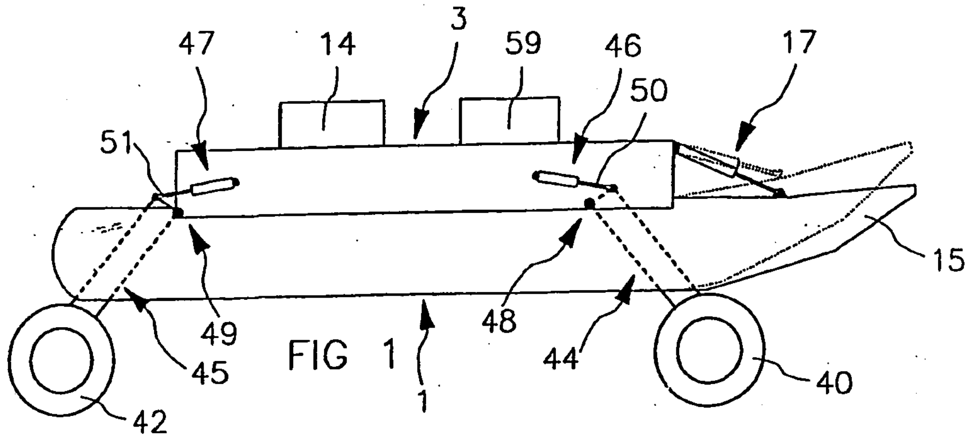

FIG 1

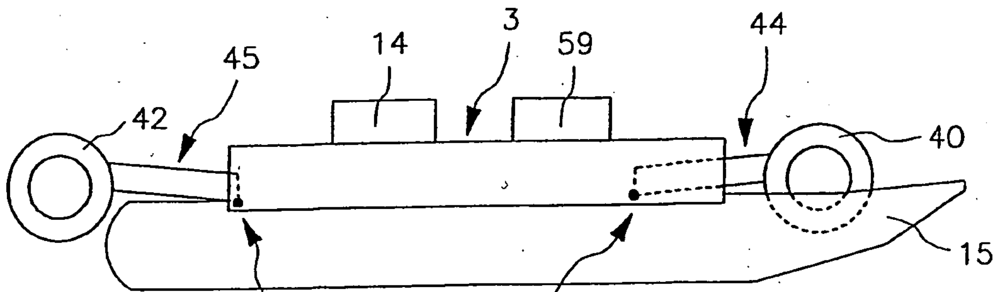

FIG 2

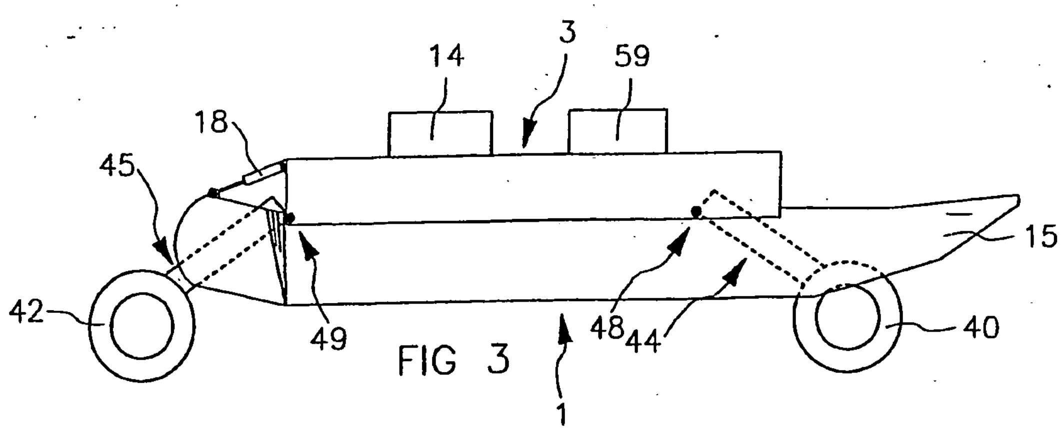

FIG 3

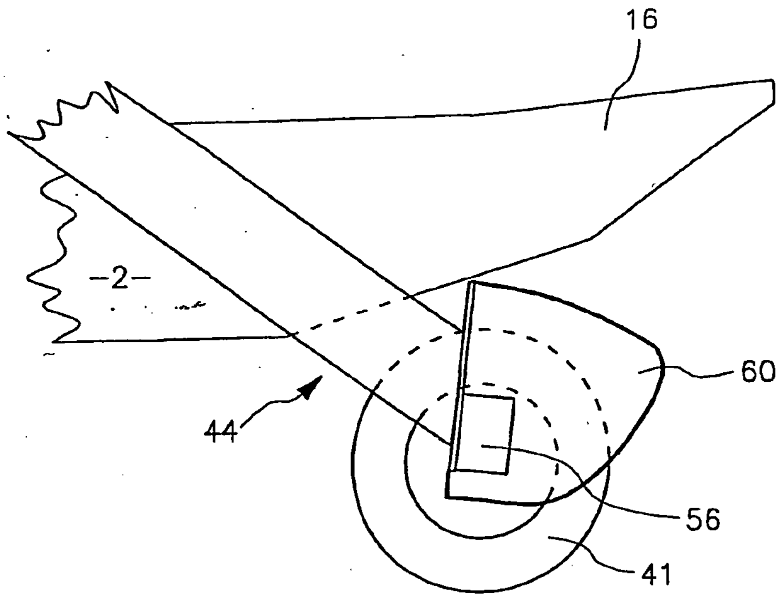

FIG 4

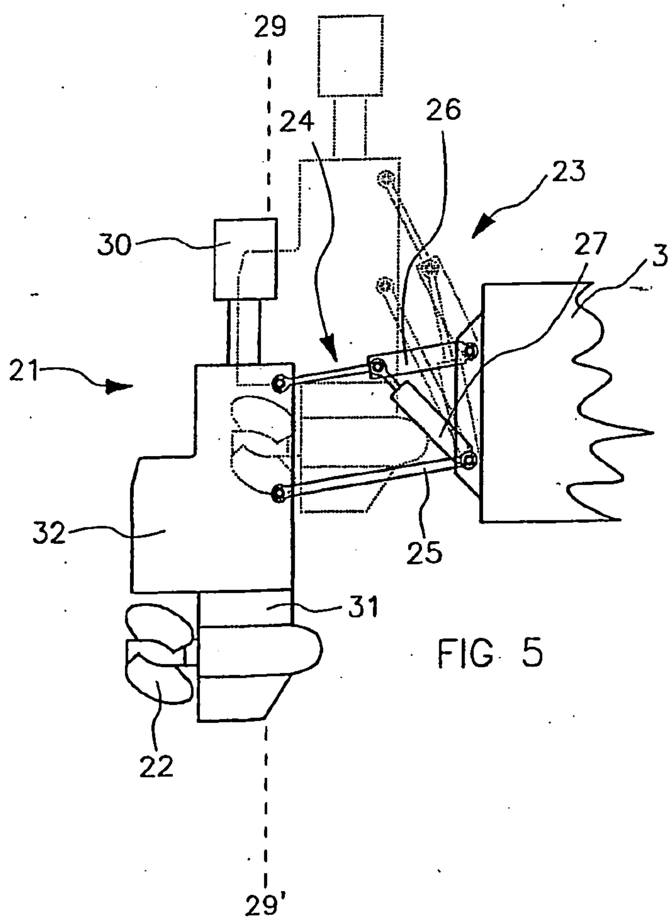

FIG 5

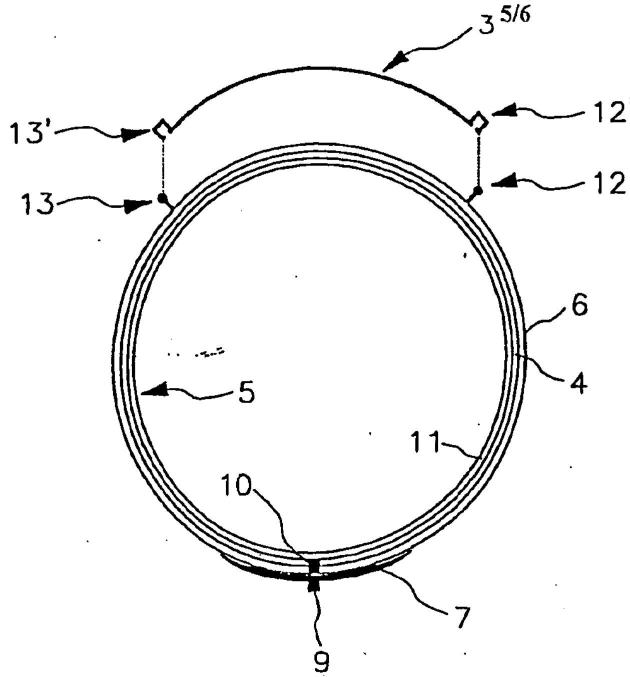

FIG 6

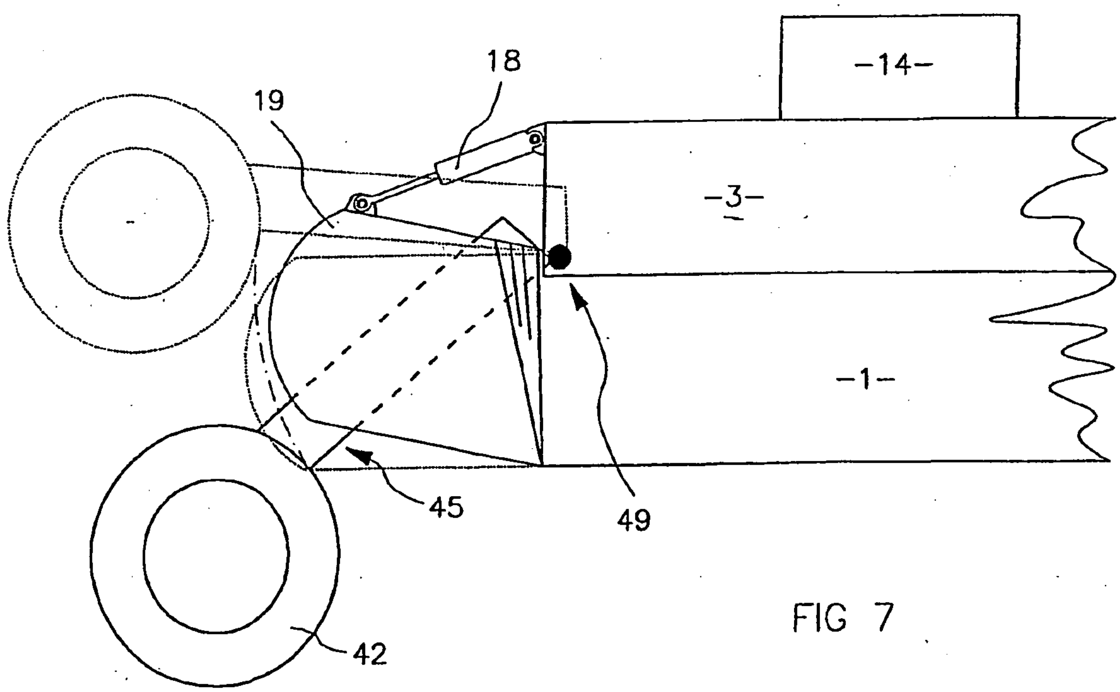

FIG 7

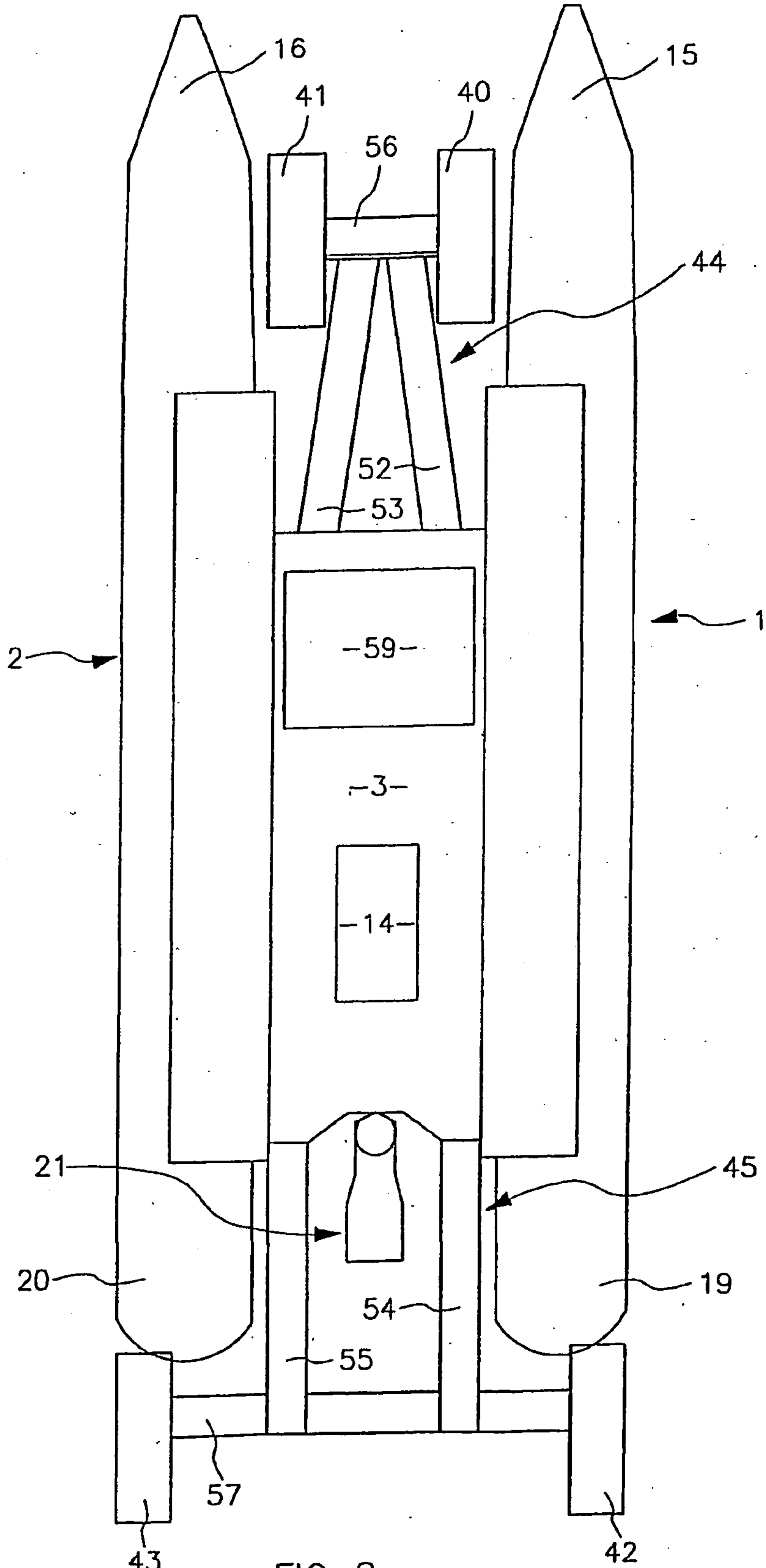

FIG 8

INTERNATIONAL SEARCH REPORT

International Application No
PCT/NZ 01/00271

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B60F3/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 B60F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	FR 2 395 160 A (LAPEYRE JEAN LOUIS) 19 January 1979 (1979-01-19)	1,5,29, 30
A	the whole document	2-4,9, 15,25, 31,32
X	FR 543 302 A (VARGOZ ADOLPHE) 1 September 1922 (1922-09-01)	1
A	the whole document	2-4,9, 15,25, 29,30,32
A	US 3 595 198 A (HACKER FRITZ) 27 July 1971 (1971-07-27) figure 1	1

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"O" document referring to an oral disclosure, use, exhibition or other means

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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
9 April 2002	17/04/2002
Name and mailing address of the ISA European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Authorized officer Cauderlier, F

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2 514 488 A (KREYER JOHN G ET AL) 11 July 1950 (1950-07-11) column 8, line 23 - line 24; figures 6,7 ----	1

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